

**CLAIMS**

What is claimed is:

1. An energy efficient pump apparatus, comprising:
  - a first closed conduit having first and second ends;
  - a first movable piston with a closed end having an effective length A greater than the median radius of said conduit, said first piston loosely disposed within said first closed conduit such that a gap having a predefined median size is formed between said first piston and said first closed conduit;
  - wherein said first piston is movable in said closed conduit at a velocity relative to said conduit such that as said first piston moves along said closed conduit said first piston creates a substantial tortuous leak path forming a hydrodynamic seal between said first piston and said closed conduit thereby enabling said first piston to displace fluid along said closed conduit; and;
  - wherein the efficiency of said hydrodynamic seal is based on said predefined median size of said gap, said effective length A of said first piston and said velocity of said piston.
2. A pump apparatus as in claim 1 wherein said first piston further includes a one-way valve disposed therein; wherein when said first piston is moved back and forth along said closed conduit, said piston pulls and pumps fluid along said closed conduit.
3. A pump apparatus as in claim 2 wherein said closed conduit is positioned at an angle other than horizontal and said closed conduit further includes a one-way inlet valve at a lower portion thereof; wherein when said first piston is moved up and down along said closed conduit, fluid is pulled into and pumped up said first closed conduit.

4. A pump apparatus as in claim 3 further comprising a drive member connected to a top end of said first piston and operable to move said first piston up and down along said closed conduit.
5. A pump apparatus as in claim 4 wherein said drive member is flexible.
6. A pump apparatus as in claim 5 further comprising a pipe having top and second ends; said second end of said pipe attached to said top end of said first closed conduit; wherein during the up-stroke of said pump apparatus, said first piston is pulled up by said drive member and during the down-stroke of said pump apparatus, said first piston is pulled down by gravity, thereby pulling and pumping fluid into and up said pipe.
7. A pump apparatus as in claim 6 further comprising:
  - a second closed conduit having top and second ends,
  - a second movable piston loosely disposed within said second closed conduit such that a gap having a predefined median size is formed between said second piston and said second closed conduit; said second piston having a rigid drive member connected thereto;
  - said second end of said second closed conduit attached to said first end of said pipe;
  - an outlet at the lower end of said second closed conduit;
  - wherein during operation of said pump apparatus said first and second pistons move in said respective closed conduits to facilitate fluid flow into said first closed conduit, into and up said pipe on the up-stroke, and out of said outlet under pressure on the down-stroke.

8. A pump apparatus as in claim 7 further comprising an outlet pipe connected to the outlet at the lower end of said second closed conduit and a one-way outlet valve disposed in said outlet pipe to limit the amount of force required to move said first and second pistons on the up-stroke.
9. A pump apparatus as in claim 7 further comprising:  
a closed sleeve outlet conduit comprising a closed sleeve and an outlet pipe connected to an upper portion of said closed sleeve;  
said closed sleeve outlet conduit covering said second conduit and creating a sleeve-conduit gap between the outer walls of said second conduit and the inner walls of said closed sleeve, such that said sleeve-conduit gap is sealed both at the bottom and the top of said closed sleeve outlet conduit, and such that any fluid flowing through said outlet at the lower end of said second closed conduit flows into said sleeve-conduit gap;  
wherein during operation of said pump apparatus said first and second pistons move in said respective closed conduits to facilitate fluid flow into said first closed conduit, into and up said pipe and into said second closed conduit during the up-stroke, and through said opening of said second closed conduit, into said sleeve-conduit gap and out of said outlet pipe under pressure during the down-stroke.
10. A pump apparatus as in claim 9 wherein said sleeve outlet pipe includes a one-way valve disposed therein to limit the amount of force required to move said first and second pistons on the up stroke.
11. A energy efficient pump apparatus to pressurize, displace and pump a volume of fluid, comprising:

a closed conduit;

a piston assembly comprising:

a top piston having a length-wise dimension greater than that of a washer;

a bottom piston having a length-wise dimension greater than that of a washer and

flexible drive member connecting said top and bottom pistons;

said piston assembly loosely disposed within said closed conduit such that a gap

having a predefined size is formed between said pistons and said closed conduit;

said piston assembly movable in said closed conduit such that as said top and bottom

pistons move said top and bottom pistons create a substantial tortuous leak path

forming a hydrodynamic seal between said top and bottom pistons and said closed

conduit thereby enabling said piston assembly to displace said fluid;

wherein the efficiency of said hydrodynamic seal is based on said predefined size of

said gap and said length-wise dimensions of said top and bottom pistons.

12. A pump apparatus as in claim 11 wherein said closed conduit is a cylinder having an upper portion.

13. A pump apparatus as in claim 12 further comprising an outlet connected to a top region of said upper cylinder portion and a one-way outlet valve disposed in said outlet for removal of said displaced fluid.

14. A pump apparatus as in claim 13 wherein said outlet is a sleeve outlet pipe.

15. A pump apparatus as in claim 11 wherein said bottom piston includes a one-way inlet valve for fluid upflow during up stroke operation of said apparatus.

16. A pump apparatus as in claim 11 wherein said flexible drive member provides gravitational return stroke during operation of said apparatus.

17. A pump apparatus as in claim 11 wherein said flexible drive member is a cable, rope, chain, wire or a combination of the foregoing.

18. A energy efficient pump apparatus to pressurize, displace and pump a volume of fluid, comprising:

a frame;

a cylinder and pipe assembly mounted on said frame at an angle other than horizontal and comprising:

a pipe, a top cylinder, and a bottom cylinder connected to said top cylinder by said pipe;

said bottom cylinder having a bottom check valve;

said top cylinder having an outlet connected to an upper region of said top cylinder and a one-way outlet valve disposed in said outlet for removal of said displaced fluid;

a piston assembly having:

a valve-less top piston having a length-wise dimension greater than that of a washer with a closed end,

a hollow bottom piston having a length-wise dimension greater than that of a washer and further having a one-way fluid inlet valve that allows fluid to flow upwards therethrough during up stroke operation of said apparatus;

a flexible tension member connecting said top and bottom pistons at a distance such that when said piston assembly is disposed within the said cylinder and pipe assembly, said top piston is inside said top cylinder and said bottom piston is inside said bottom cylinder;

said piston assembly loosely disposed within said cylinder and pipe assembly and forming a gap having a predefined size between said pistons and said cylinders; said piston assembly movable in said cylinder and pipe assembly such that as said piston assembly moves said top and bottom pistons create a substantial tortuous leak path forming a hydrodynamic seal between said pistons and said cylinder thereby enabling said top and bottom pistons to pressurize and displace said volume of fluid; wherein the efficiency of said hydrodynamic seal is based on said predefined size of said gap and said lengths of said top and bottom pistons.

19. A pump apparatus as in claim 18 to wherein said pipe is a rigid or a flexible pipe.
20. A pump apparatus as in claim 18 wherein said outlet is a sleeve outlet pipe.
21. A pump apparatus as in claim 18 wherein said flexible drive member provides gravitational return stroke during operation of said apparatus.
22. A pump apparatus as in claim 18 wherein said flexible drive member is a cable, rope, chain, wire or a combination of the foregoing.
23. An energy efficient pump apparatus, comprising:
  - a first closed conduit having first and second ends;
  - a first movable piston with a closed end; said first piston loosely disposed within said first closed conduit such that a gap having a predefined median size is formed between said first piston and said first closed conduit;
  - wherein said first piston is movable in said closed conduit at a velocity relative to said conduit such that as said first piston moves along said closed conduit said first piston creates a substantial tortuous leak path forming a hydrodynamic seal between said

first piston and said closed conduit thereby enabling said first piston to displace fluid along said closed conduit; and;

the efficiency of said hydrodynamic seal is based on said predefined median size of said gap and said velocity of said piston;

wherein said first piston further includes a one-way valve disposed therein; wherein when said first piston is moved back and forth along said closed conduit, said piston pulls and pumps fluid along said closed conduit.

24. A pump apparatus as in claim 23 wherein said closed conduit is positioned at an angle other than horizontal and said closed conduit further includes a one-way inlet valve at a lower portion thereof; wherein when said first piston is moved up and down along said closed conduit, fluid is pulled into and pumped up said first closed conduit.

25. A pump apparatus as in claim 24 further comprising a drive member connected to a top end of said first piston and operable to move said first piston up and down along said closed conduit.

26. A pump apparatus as in claim 25 wherein said drive member is flexible.

27. A pump apparatus as in claim 26 further comprising a pipe having top and second ends; said second end of said pipe attached to said top end of said first closed conduit; wherein during the up-stroke of said pump apparatus, said first piston is pulled up by said drive member and during the down-stroke of said pump apparatus, said first piston is pulled down by gravity, thereby pulling and pumping fluid into and up said pipe.

28. A pump apparatus as in claim 27 further comprising:  
a second closed conduit having top and second ends,



a second movable piston loosely disposed within said second closed conduit such that a gap having a predefined median size is formed between said second piston and said second closed conduit; said second piston having a rigid drive member connected thereto;

said second end of said second closed conduit attached to said first end of said pipe;

an outlet at the lower end of said second closed conduit;

wherein during operation of said pump apparatus said first and second pistons move in said respective closed conduits to facilitate fluid flow into said first closed conduit, into and up said pipe on the up-stroke, and out of said outlet under pressure on the down-stroke.

29. A pump apparatus as in claim 28 further comprising an outlet pipe connected to the outlet at the lower end of said second closed conduit and a one-way outlet valve disposed in said outlet pipe to limit the amount of force required to move said first and second pistons on the up-stroke.

30. A pump apparatus as in claim 28 further comprising:

a closed sleeve outlet conduit comprising a closed sleeve and an outlet pipe connected to an upper portion of said closed sleeve;

said closed sleeve outlet conduit covering said second conduit and creating a sleeve-conduit gap between the outer walls of said second conduit and the inner walls of said closed sleeve, such that said sleeve-conduit gap is sealed both at the bottom and the top of said closed sleeve outlet conduit, and such that any fluid flowing through said outlet at the lower end of said second closed conduit flows into said sleeve-conduit gap;



wherein during operation of said pump apparatus said first and second pistons move in said respective closed conduits to facilitate fluid flow into said first closed conduit, into and up said pipe and into said second closed conduit during the up-stroke, and through said opening of said second closed conduit, into said sleeve-conduit gap and out of said outlet pipe under pressure during the down-stroke.

31. A pump apparatus as in claim 30 wherein said sleeve outlet pipe includes a one-way valve disposed therein to limit the amount of force required to move said first and second pistons on the up stroke.